ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

AVIAN DIVERSITY IN RELATION TO CELL PHONE TOWER IN AGRICULTURAL CROP FIELDS OF LUDHIANA, PUNJAB, INDIA

Jashanpreet Kaur[1], Tejdeep Kaur Kler[2], Jasjit Singh Kang[3] and Manoj Kumar[4]

1. M.Sc. Student Department of Zoology, Punjab Agricultural University, Ludhiana-141004, Punjab, India.
2. Ornithologist, Department of Zoology, Punjab Agricultural University, Ludhiana.
3. Senior Agronomist, Department of Agronomy, Punjab Agricultural University, Ludhiana.
4. Assistant Ornithologist, Department of Zoology, Punjab Agricultural University, Ludhiana.

Manuscript Info

Manuscript History:

Received: 18 November 2015
Final Accepted: 22 December 2015
Published Online: January 2016

Key words:
Bird abundance, Cell phone towers, Electromagnetic radiations, Electric field strength, and Species richness.

Corresponding Author

Tejdeep Kaur Kler

Abstract

Electromagnetic radiations from cell phone towers has become a global concern for its effects on human health as well as on other fauna. This paper summarizes the effect of electromagnetic radiation from cell phone towers on bird abundance and diversity in crop fields. Bird observations were recorded within 200 and 1000 m radius of cell phone tower in crop fields of Gill and Alamgir villages of Ludhiana, Punjab, India from May 2014 to April 2015. Species richness was found to be more within 1000 m radius as compared to 200 m radius of cell phone tower in both the villages. Common Moorhen, Black-winged Stilt, Jungle Prinia, Plain Prinia and Brahminy Starling were not found within 200 m radius of cell phone tower in both the villages. In Gill village, 17 avian species were observed common both within 200 m and 1000 m radius of cell phone tower; out of these significant difference was found between 5 avian species. In Alamgir village, 15 avian species were observed common both within 200 m and 1000 m radius of cell phone tower; out of these significant difference was found between 7 avian species.

.

Introduction:-

Rapid development of telecommunication devices in last decades has caused enhancement of human interference with nature. According to Telecom Regulatory Authority of India the percentage of telephone subscribers using wireless form of communication in urban area is 63.27% and rural area is 33.20%. The communication by mobile phone takes place by transmission of radio waves through a network of base stations. The cell site antenna emit a frequency of 900 or 1800 MHz, pulsed in a very low frequency generally known as microwaves, similar to radar spectrum. Birds are good monitor of an ecosystem because of their thin skull and high mobility (Liboff and Jenrow 2000). Two hundred forty one bird species are at mortality risk from both tower collisions and from exposure to the radiation from towers (Reynolds 2001). Mouritsen (2005) estimated that 6.8 million bird deaths a year may result from collisions with towers. As a result, undesirable impacts are noticed on biological, physical and ecological systems (Gottlieb *et al* 2011). A recent study has shown the toxic effects of EMF on developing chick embryo brain cell organelles and membranes, affected blood- brain barrier permeability, increased cellular apoptosis and torn blood vessel (Kalantari *et al* 2014). The present research is aimed to observe the effect of electromagnetic radiations from cell phone towers on bird abundance and diversity in crop fields in selected villages of Punjab, India.

Material and Methods:-

The present study was undertaken from May 2014 to April 2015 in two villages namely Alamgir and Gill village falling in district Ludhiana, Punjab, India. The point count method was used to observe the composition of birds. Birds were identified according to the Book of Indian birds (Ali 2012).

Location I:-
Location I was Gill village. Gill village is a village in Ludhiana district of Punjab state, India. Gill village lies at latitude of 30°50'46.33"N and longitude of 75°51'44.54"E; 251 m above the mean sea level. Location I comprised chiefly of crop fields having individual trees on field bunds and a few farm houses. There were 18 tree species including 6 fruit trees in crop fields and farm houses. There were 10 farm houses and 4 shops falling within 200 m radius and 25 houses and 8 shops situated within 1000 m radius of cell phone tower.

Location II:-
Location II was Alamgir village. Alamgir village is a village in Ludhiana district of Punjab state, India. Alamgir village lies at latitude of 30°48'4.16"N and longitude of 75°51'29.23"E; 251 m above the mean sea level. Location II comprised mainly crop fields having individual trees on field periphery and a few farm houses. There were 13 tree species including 4 fruit trees in crop fields and farm houses. Within 200 radius of cell phone tower there were 5 farm houses and within 1000 m radius there was one religious place along with 12 shops and 20 farm house.

Data has been recorded near cell phone towers that were located in crop fields. Counting of birds was done within 200 m radius and 1 km radius of cell phone tower. In location II, twin cell phone towers were taken for said study in crop fields. These cell phone towers were taken as one unit because the distance between two towers was just 20 feet. Activity of birds like foraging, perching, roosting, flocking, nesting were also observed. The parameters like species richness, relative abundance were calculated. Species richness is the total number of birds recorded in an area. Relative abundance was calculated as: ni/N X 100where ni is the number of birds of *ith* species and N is the total number of birds recorded. Species diversity (H) was calculated by Shannon-Wiener index (Spellerberg and Fedor 2003). Species diversity (H) and Species evenness (J) were calculated from bird abundance data (Krebs 1985). Mann-Whitney U test was performed to find the difference between population of common bird species within 200 m and 1000 m radius of cell phone tower. Axis RF strength meter WACO 195 was the instrument used to measure the frequencies of radiations emerging from cell phone tower.

Results and Discussion: -

At location I, annual species richness of 19 and 28 bird species had been observed within 200 m and 1000 m radius of cell phone tower in agricultural fields respectively. House Crow, Common Myna and Blue Rock Pigeon were found to be most abundant species in the same sequence both within 200 m and 1000 m radius of cell phone tower. Nine bird species were not recorded within 200 m radius of cell phone tower. These were Indian Robin, Brahminy Starling, Black-winged Stilt, Common Babbler, Jungle Prinia, Crested Bunting, Black-headed Munia and Plain Prinia. Within 1000 m radius of cell phone tower number of ornamental trees and houses were more as compared to 200 m radius of cell phone tower. So some avian species like Jungle Prinia, Plain Prinia, Indian Robin, Crested Bunting, and Common Babbler were recorded there (Table 1).Seventeen bird species were recorded as the common avian species within 200 m and 1000 m radius of cell phone tower. Significant difference was observed in the abundance of species like Common Myna, Ring Dove, Rose-ringed Parakeet, Ashy Prinia and Bank Myna at location I. Guha (2011) found that birds like Doves, Sparrows, and Prinia were not found near cell phone tower. Results from the present study also indicate that Indian Robin, Jungle Prinia and Plain Prinia were not recorded within 200 m radius of cell phone tower but these species were present within 1000 m radius of cell phone tower.

At location II, annual species richness of 19 and 22 bird species were recorded within 200 m and 1000 m radius of cell phone tower in crop fields respectively. It was inferred from the data that House Crow, Common Myna and Blue Rock Pigeon were most abundant species both within 200 m and 1000 m radius of cell phone tower. This finding was similar to the one recorded in the Gill village. Red-collared Dove, Paddyfield Pipit, Common Moorhen, Brahminy Starling, Black-winged Stilt and Common Swallow were not found within 200 m radius of cell phone tower (Table 1).The presence of Common Moorhen, Black-winged Stilt and Common Swallow seemed to be related to the village pond located within 1000 m radius of cell phone tower. Seven bird species were recorded as the common avian species within 200 and 1000m radius of cell phone tower. Significant difference was observed in the abundance of bird species like House Crow, Common Myna, Blue Rock Pigeon, and Eurasian-collared Dove, Red-wattled Lapwing, Black drongo and Cattle Egret in location II.

A total of 28 and 24 avian species were found in location I and location II respectively. Spotted Owlet, Red-collared Dove and Wire-tailed Swallow were the bird species that were only present in location II. Spotted Owlet was seen sitting at the Pipal (*Ficus religiosa*) tree. A pair of Wire-tailed Swallow was also observed perching on the electric wire. Black-headed Munia, Ashy Prinia, Crow Pheasent, White Pigeon, Crested Bunting, Plain Prinia and Jungle

Prinia were not recorded within 200 m radius of cell phone tower in both the villages (Table 1).Species richness was recorded more in location I as compared to location II. In location I, tree density was more as compared to location II. Due to the presence of some ornamental trees in farm house, bird species like Jungle Prinia, Plain Prinia, Ashy Prinia and Crested Bunting were recorded there. Crow Pheasent was found roaming in bushes that were present within 1000 m radius of cell phone tower in location I. At location II, species richness was less. It could be because of effect of electromagnetic radiations from twin tower at location II.

At location I, average, power density of cell phone tower measured was 0.1544 watt/m^2 below the tower and 0.054 watt/m^2 25 m away from cell phone tower. At location II, average power density of twin cell phone tower was 0.7864 watt/m^2 below the tower and 0.637 watt/m^2 25 m away from twin cell phone tower. It has been mentioned by Department of Telecommunications (2013) in advisory guidelines for State Government for issue of clearance for installation of mobile towers that the power density safe limits for the frequency 1800 MHz (Mega Hertz) are 0.45 watt/m^2. Power density as measured in the present study below the tower and 25 m away from the tower at both the locations were within the safe limit as recommended by Department of Telecommunications.

Bird community characteristics within 200 m and 1000 m radius of cell phone tower at different developmental stages of paddy crop in location I and location II:

A total of 15 and 18 avian species were recorded within 200 m and 1000 m radius of cell phone tower at different developmental stages (Seedling, transplanting, tillering and ripening) of paddy crop at location I. House Crow, Common Myna were the most abundant species both within 200 m and 1000 m radius of cell phone tower (Table 2). Eurasian-collared Dove, Ashy Prinia, Jungle Prinia, Crow Pheasant, Red-vented Bulbul and Pied Myna were not found within 200 m radius of cell phone tower at all the 4 stages of paddy. Common Swallow was the only species that was recorded within 200 m radius of cell phone tower at transplanting stage but not within 1 km radius (Table 4). Six bird species were recorded to be common both within 200 m and 1000 m radius of cell phone tower at different developmental stages of paddy at location I. No significant difference was found between the populations of these six species.

At location II, a total of 16 and 18 bird species were found within 200 and 1000 m radius of cell phone tower at different developmental stages of paddy crop. House Crow, Common Myna were recorded as the most abundant species both within 200 m and 1000 m radius of cell phone tower (Table 2). This observations was found to be same at both the locations. Eurasian-collared Dove, Jungle Prinia, Common babbler, Red-collared Dove, Common Moorhen, Indian Robin and Brahminy Starling were not found within 200 m radius of cell phone tower at all the four stages of paddy crop. Jungle Babbler was found at the seedling and transplanting stage within 200 m radius of cell phone tower. Spotted owlet, House Sparrow, Wire-tailed Swallow were found at the seedling stage within 200 m radius. Red-vented Bulbul was recorded at the transplanting and ripening stage within 200 m radius. Pied Myna was found at the transplanting stage within 200 m radius (Table 4). Baron (2010) mentioned that the microwave radiations emitted from the tower produce heating effect on body of birds. To avoid such happening birds try to keep themselves away from cell towers as far as possible. The present study confirms this observation. Five avian species were recorded as the common bird species within 200 m and 1000 m radius of cell phone tower at different developmental stages of paddy at location II. No significant difference was found in the population of these fiveavian species.

A total of 22 and 23 bird species were recorded in location I and II respectively. Bird species like Eurasian-collared Dove, Ashy Prinia, Crow Pheasent, Jungle Prinia, Red-vented Bulbul, Red-collared Dove, Brahminy Starling, Indian Robin and Common Moorhen were not recorded within 200 m radius of cell phone towerin both the villages. Spotted owlet, house Sparrow, Wire-tailed Swallow and Pied Myna were found within 200 m radius of cell phone tower, but these bird species were not found within 1000 m radius of cell phone tower. Bank Myna was present within 200 m radius of cell phone tower in location I only (Table 4).

Bird Community characteristics within 200 m and 1000 m radius of cell phone tower at different developmental stages of wheat crop in location I and location II:

At location I, a total of 15 and 24 bird species were recorded within 200 m and 1000 m radius of cell phone tower at different developmental stages (Preparatory tillage, sowing, seedling and ripening) of wheat crop respectively. House Crow, Common Myna and Blue Rock Pigeon were the most abundant species both within 200 m and 1000 m radius of cell phone tower (Table 3).Common Babbler, Red-vented Bulbul, Indian Robin, Brahminy Starling, Black-winged Stilt, House Sparrow, Jungle Prinia, Crested Bunting, Black-headed Munia, Plain Prinia and Ring Dove

were not recorded within 200 m radius of cell phone tower at all the four stages of wheat. White-breasted Kingfisher was recorded within 200 m radius at the seedling stage. Common Babbler was found within 200 m radius of cell phone tower at the seedling and ripening stage (Table 5).Four avian species were recorded as the common bird species in within 200 m and 1000 m radius of cell phone tower in wheat fields at location I. No significant difference was found between the populations of these four bird species.

At location II, a total of 16 and 19 bird species were recorded within 200 m and 1000 m radius of cell phone tower at different developmental stages of wheat crop respectively. House Crow, Common Myna and Blue Rock Pigeon were recorded as most abundant species both within 200 m and 1000 m radius of cell phone tower (Table 3). Bird species like Common Babbler, Paddyfield Pipit, Common Moorhen, Brahminy Starling, Pied Myna, Black-winged Stilt, and House Sparrow were not recorded within 200 m radius of cell phone tower. Wire-tailed Swallow, Red-vented Bulbul and Indian Robin were found within 200 m radius of cell phone tower but not within 1000 m radius of cell phone tower (Table 5).Four bird species were recorded as the common bird species within 200 m radius and 1000 m radius of cell phone tower in wheat fields at location II. No significant difference was found between the populations of these four species.

A total of 26 and 23 avian species were recorded in location I and II respectively. Brahminy Starling, Crested Bunting, Jungle Prinia, Ring Dove, Common Babbler, Black-winged Stilt, Black-headed Munia, Plain Prinia, Pied Myna, House Sparrow, Paddyfield Pipit and Common Moorhen. Red-collared Dove were not found within 200 m radius of cell phone tower at both the locations. Red-vented Bulbul and Wire-tailed Swallow were found within 200 m radius of cell phone tower in location I and II respectively (Table 5).

Table 1: Annual Relative abundance (%) of bird species within 200 m and 1000 m radius of cell phone tower in crop fields of Gill and Alamgir villages from May 2014 to April 2015.

Bird species	**Annual abundance (%) Within 200 m radius**		**Annual abundance (%) Within 1000 m radius**	
	Gill village	**Alamgir village**	**Gill village**	**Alamgir village**
Common Myna	18.36	20.34	17.76	18.90
House Crow	22.95	21.87	21.81	20.40
Red-wattled Lapwing	10.69	9.76	10.19	7.56
Spotted Owlet	-	0.66	-	-
Black Drongo	1.31	3.41	0.98	1.15
Rose-ringed Parakeet	2.56	2.64	2.52	5.93
Blue Rock Pigeon	11.79	14.81	12.84	12.78
Eurasian-collared Dove	4.40	6.25	5.33	3.82
Cattle Egret	4.45	4.60	3.11	7.56
Red-collared Dove	-	-	-	2.42
Asian Koel	1.76	1.08	1.84	1.08
Wire-tailed Swallow	-	1.31	-	-
Red-vented Bulbul	0.97	0.18	1.93	0.89
Jungle Babbler	7.04	3.86	2.51	4.39
Common Hoopoe	0.54	1.05	1.12	0.61
White-breasted Kingfisher	0.82	0.87	0.95	0.82
Pied Myna	-	0.50	-	0.39
Bank Myna	3.04	0.50	2.58	-
Paddyfield Pipit	1.00	-	1.14	2.56
Common Moorhen	-	-	-	1.67
Indian Robin	-	0.52	1.92	0.16
House Sparrow	-	0.18	-	0.42
Brahminy Starling	-	-	2.40	2.46
Black-winged Stilt	-	-	1.92	3.18
Ashy Prinia	0.49	-	1.18	-
Ring Dove	3.04	-	2.03	-
Common Swallow	0.51	-	0.91	0.92
Crow Pheasent	0.54	-	0.74	-
Common Babbler	-	-	1.13	-
Jungle Prinia	-	-	1.08	-
Crested Bunting	-	-	0.40	-
Indian Robin	-	-	0.39	-
Black headed Munia	-	-	0.37	-
Plain Prinia	-	-	0.73	-

Table 2: Relative abundance (%) of bird species within 200 m and 1000 m radius of cell phone tower in paddy fields of Gill and Alamgir village from May 2014 to October 2014.

Bird species	**Relative abundance (%) Within 200 m radius**		**Relative abundance (%) Within 1000 m radius**	
	Gill village	**Alamgir village**	**Gill village**	**Alamgir village**
Common Myna	17.56	18.15	15.93	17.68
House Crow	20.29	20.25	19.87	18.67
Red-wattled Lapwing	12.15	12.32	9.10	8.32
Blue Rock Pigeon	10.53	11.70	12.39	11.04
Cattle Egret	11.40	7.90	5.86	8,22
Rose-ringed Parakeet	4.96	6.76	5	5.94
Black Drongo	2.03	3.33	1.05	2.83
Asian Koel	4.08	3.65	4.51	2.66
Jungle Babbler	-	3.93	4.81	
Eurasian-collared Dove	-	6.75	5.13	5.14
Spotted Owlet	-	3.61	-	
Common Hoopoe	4	3.05	3.65	2.17
Wire-tailed Swallow	-	3.93	-	-
Red-vented Bulbul	-	7.03	6.48	-
Pied Myna	-	7.1	1.66	-
White-breasted Kingfisher	2.63	1.2	-	1.74
Common Babbler	9.36	-	-	6
Common Swallow	2.16	-	-	3.92
Paddyfield Pipit	6.73	-	4.81	4.86
Ring Dove	6.73	-	5.64	-
Bank Myna	8	-	-	-
Red-collared Dove	-	-	-	3.25
Common Moorhen	-	-	-	7.84
Indian Robin	-	-	-	1.96
Brahminy Starling	-	-	-	5.46
Ashy Prinia	-	-	2.11	-
Jungle Prinia	-	-	6.78	-
Crow Pheasent	-	-	1.97	-

Table 3: Relative abundance (%) of bird species within 200 m and 1000 m radius of cell phone tower in wheat fields of Gill and Alamgir village from November 2014 to April 2015.

Bird species	**Relative abundance (%) Within 200 m radius**		**Relative abundance (%) Within 1000 m radius**	
	Gill village	**Alamgir village**	**Gill village**	**Alamgir village**
Common Myna	18.01	22.92	18.06	19.63
House Crow	25.68	22.52	22.21	21.62
Blue Rock Pigeon	12.24	14.08	13.13	14.79
Red-wattled Lapwing	13.03	9.58	10.91	6.36
Cattle Egret	6.66	9.21	3.26	7.25
Rose-ringed Parakeet	4.78	5.26	6.97	6.37
Black Drongo	1.21	4.09	4.65	2.21
Asian Koel	5.88	3.94	2.17	1.72
Jungle Babbler	-	6.91	4.65	
Eurasian-collared Dove	6.67	9.41	6.44	6.41
Common Hoopoe	1.21	2.63	1.63	5.26
Wire-tailed Swallow	-	2.77	-	-
White-breasted Kingfisher	3.75	2.87	-	1.3
Red-collared Dove	-	6.13	-	3.05
Red-vented Bulbul	-	1.38	3	-
Indian Robin	-	1.38	1.56	-
Common Babbler	10.81	-	-	5.53
Bank Myna	5.53	-	4.65	-
Crow Pheasent	6.81	-	1.49	-
Ashy Prinia	2.94	-	3.27	-
Paddyfield Pipit	-	-	-	3.44
Common Moorhen	-	-	-	6.03
Brahminy Starling	-	-	5.94	6.03
Pied Myna	-	-	-	1.76
Black-winged Stilt	-	-	4.62	13.27
House Sparrow	-	-	1.40	3.44
Jungle Prinia	-	-	4.65	-
Crested Bunting	-	-	1.56	-
Black-headed Munia	-	-	2.17	-
Plain Prinia	-	-	4,34	-
Ring Dove	-	-	5.09	-

Table 4: Relative abundance (%) of bird species within 200 m and 1000 m radius of cell phone tower at different developmental stages of paddy crop in Gill and Alamgir village from May 2014 to October 2014.

Bird species	Relative abundance (%) Within 200 m radius								Relative abundance (%) Within 1000 m radius							
	Gill village				Alamgir village				Gill village				Alamgir village			
	S.S	T.S	T.S	R.S	S.S	T.S	T.S	R.S	S.S	T.S	T.S	R.P	S.S	T.S	T.S	R.P
House Crow	24.65	12	16.83	23.68	19.27	14.81	26.92	20	23.15	13.75	22.58	20	19.29	14.28	19.14	19.60
Common Myna	19.17	16	14.66	18.42	18.07	14.81	23.07	16.66	22.10	10.52	9.12	15	17.54	14.28	21.27	17.64
Red-wattled Lapwing	10.95	12	12.51	13.15	9.63	14.81	9.53	13.33	10.52	7.89	9.67	10.33	9.64	7.14	6.38	5.88
Blue Rock Pigeon	10.59	12	10.52	12.51	10.84	11.11	9.53	11.33	13.68	7.89	6.67	18.33	12.88	9.52	8.63	11.73
Cattle Egret	9.58	8	20.02	10.52	6.02	7.40	11.53	6.66	8.42	5.26	6.67	3.33	8.77	9.52	10.63	-
Rose-ringed Parakeet	2.73	8	4.16	-	6.02	-	7.61	6.66	-	-	-	5	4.38	7.14	6.38	5.88
Black Drongo	1.36	-	-	2.63	3.61	3.70	7.69	3.33	1.05	-	-	-	1.75	-	-	3.92
Asian Koel	4.10	4	4.16	-	3.61	3.70	-	-	4.21	5.26	6.67	-	3.50	2.38	2.12	-
Jungle Babbler	8.21	-	-	10.52	6.02	7.40	-	-	3.15	-	6.67	-				
Ring Dove	2.73	8	8.33	7.89	2.40	11.11	-	-	4.21	5.26	6.67	6.66				
Paddyfield Pipit	2.73	8	8.33	7.89					-	7.89	3.22	3.33	4.38	4.76	6.38	3.92
Bank Myna	-	8	-	-					-	-	-	-				
Common Hoopoe	-	4	-	-	2.40	3.70	-	-	2.10	5.26	-	3.33	-	-	2.17	-
Common Swallow	-	-	4.16	-					-	-	-	-	-	-	-	3.92
White-breasted Kingfisher	-	-	-	2.63	1.20	-	-	-	-	-	-	1.66	1.74	-	-	-
Eurasian-collared Dove	-	-	-	-	-	-	-	-	2.10	8.52	3.22	5.66	4.38	7.14	-	3.92
Ashy Prinia	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-
Crow Pheasent	-	-	-	-	-	-	-	-	1.05	-	3.22	1.66	-	-	-	-
Jungle Prinia	-	-	-	-	-	-	-	-	-	5.26	-	3.33	-	4.76	-	-
Red-vented Bulbul	-	-	-	-	-	7.40	-	6.66	-	-	6.67	-	-	-		-
Spotted owlet	-	-	-	-	3.61	-	-	-	-	-		-	-	-	-	-
House Sparrow	-	-	-	-	1.02	-	-	-	-	-	-	-	-	-	-	-
Wire-tailed Swallow	-	-	-	-	1.20	-	-	6.66	-	-	-	-	-	-	-	-
Pied Myna	-	-	-	-	-	-	7.10	-	-	-	-	-	-	-	-	-
Common Babbler	-	-	-	-	-	-	-	-	-	-	-	-	4.38	9.52	4.25	5.88
Red-collared Dove	-	-	-	-	-	-	-	-	-	-	-		-	4.76	1.75	-
Brahminy Starling	-	-	-	-	-	-	-	-	-	-	-	-	6.14	4.78	-	-
Indian Robin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.96
Common Moorhen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.84
Species Richness	11	11	10	10	12	11	12	13	15	11	8	9	13	13	11	12
Diversity	2.32	2.16	2.16	2.02	2.15	2.25	2.29	2.37	2.34	2.29	2.10	2.05	2.36	2.31	2.25	2.20
Evenness	0.96	0.93	0.92	0.86	0.84	0.99	0.92	0.87	0.91	0.91	0.92	0.89	0.90	0.94	0.90	0.87

S.S – Seedling stage; T.S –Transplanting stage; T.S – Tillering stage; R.S – Ripening stage

Table 5: Relative abundance (%) of bird species within 200 m and 1000 m radius of cell phone tower at different developmental stages of wheat crop in Gill and Alamgir village from November 2014 to April 2015.

Bird species	Relative abundance (%) Within 200 m radius								Relative abundance (%) Within 1000 m radius							
	Gill village				Alamgir village				Gill village				Alamgir village			
	P.T	S.S	S.S	R.P	P.T	S.S	S.S	R.P	P.T	S.S	S.S	R.P	P.T	S.S	S.S	R.P
House Crow	26.66	28.57	25.06	22.05	20.68	25.92	26.38	17.10	20.93	23.25	22.95	21.73	24.32	21.05	24.77	16.37
Common Myna	20	17.85	19.51	14.70	27.58	22.22	23.61	15.78	16.27	18.66	18.85	18.47	21.62	18.42	22.12	16.37
Blue Rock Pigeon	13.33	10.71	14.63	10.29	12.34	14.81	18.05	13.15	13.95	11.62	13.93	13.04	18.91	15.78	13.27	11.20
Eurasian-collared Dove	6.66	7.14	6.09	-	10.34	11.11	6.94	9.21	4.65	-	4.91	9.78	8.10	-	4.24	6.89
Jungle Babbler	-	14.28	-	7.35	6.78	7.40	-	6.57	-	-	-	-	8.10	-	4.24	6.89
Black Drongo	-	-	1.21	-	3.44	4.54	2.77	9.21	-	4.65	-	-	2.70	-	-	3.72
Red-wattled Lapwing	11.33	10.71	13.41	12.70	6.89	11.11	11.11	9.21	11.62	10.62	10.65	9.78	5.40	7.89	3.53	8.62
Cattle Egret	6.66	-	-	-	-	-	-	9.21	-	-	-	3.26	8.10	10.52	2.65	7.75
Crow Pheasent	3.33	-	-	-8.29					-	-	0.81	2.17	-	-	-	
White-breasted Kingfisher	-	3.57	-	-	3.44	-	-	1.31	-	2.32	0.81	1.08	-	-	0.88	1.72
Rose-ringed Parakeet	-	7.14	2.43	-	-	-	-	5.26	6.97	6.97	-	-	5.40	7.89	6.19	6.03
Bank Myna	10	-	3.65	2.94	-	-	-	-	-	4.65	-	-	-	-	-	-
Common Hoopoe	-	-	1.21	-	-	-	-	2.63	-	-	1.63	-	-	5.26	-	-
Ashy Prinia	-	-	-	2.94	-	-	-	-	-	-	3.27	-	-	-	-	-
Asian Koel	-	-	-	5.88	-	-	-	-3.94	-	-	-	2.17	-	-	-	1.72
Brahminy Starling	-	-	-	-	-	-	-	-	6.97	-	4.91	-	-	-	-	6.03
Crested Bunting	-	-	-	-	-	-	-	-	2.31	-	0.81	-	-	-	-	-
Red-vented Bulbul	-	-	-	-	-	-	1.38	-	4.65	-	3.27	1.08	-	-	-	
Jungle Prinia	-	-	-	-	-	-	-	-	4.65	-	-	-	-	-	-	-
Indian Robin	-	-	-	-	-	-	2.77	-	-	2.32	0.81	-	-	-	-	-
Ring Dove	-	-	-	-	-	-	-	-	-	9.30	1.63	4.34	-	-	-	-
Common Babbler	-	-	-	-	-	-	-	-	-	4.65	0.81	4.34	-	-	-	-
Black-winged Stilt	-	-	-	-	-	-	-	-	--	-	4.92	4.34	-	-	13.27	-
Black-headed Munia	-	-	-	-	-	-	-	-	-	-	-	2.17	-	-	-	-
Plain Prinia	-	-	-	-	-	-	-	-	-	-	-	4.34	-	-	-	-
Wire-tailed Swallow	-	-	-	-	-	-	2.77	-	-	-	-	-	-	-	-	-
Red-collared Dove	-	-	-	-	10.34	7.40	4.16	2.63	-	-	-	-	-	-	3.53	2.58
Pied Myna	-	-	-	-	-	-	-	-	-	--	-	-	-	-	1.76	-
House Sparrow	-	-	-	-	--	-	-	-	-	-	-	-	-	-	0.88	-
Paddyfield Pipit		-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.44
Common Moorhen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.03
Species Richness	8	8	9	9	10	11	16	15	9	8	10	13	8	8	13	15
Diversity	1.91	1.91	2.02	2.19	2.22	1.93	2.35	2.31	2.25	2.19	2.25	2.31	2.30	2.17	2.26	2.35
Evenness	0.92	0.91	0.84	0.91	0.90	0.81	0.80	0.80	0.91	0.89	0.92	0.91	0.91	0.87	0.94	0.92

P.T – Preparatory tillage; S.S –Sowing stage; S.S –Seedling stage; R.S –Ripening stage

Table 6: Overall avian species found in crop fields of both the locations with their scientific names.

S. No.	Avian species (Common name)	Avian species (Zoological name)
1.	Common Myna	*Acridotheres tristis*
2.	House crow	*Corvus splendens*
3.	Red-wattled Lapwing	*Venellus indicus*
4.	Spotted owlet	*Athene brama*
5.	Black Drongo	*Dicrurus macrocercus*
6.	Rose- ringed Parakeet	*Psittacula krameri*
7.	Blue Rock pigeon	*Columba livia*
8.	Eurasian- collared Dove	*Streptopelia decaocto*
9.	Cattle Egret	*Bubulcus ibis*
10.	Red-collared Dove	*Streptopelia capicola*
11.	Asian Koel	*Eudynamys scolopacea*
12.	Wire-tailed Swallow	*Hirundo fluvicola*
13.	Red-vented Bulbul	*Pycnonotus leucotis*
14.	Jungle Babbler	*Turdoides striatus*
15.	Common Hoopee	*Upupa epops*
16.	White-breasted Kingfisher	*Halcyon smyrnensis*
17.	Pied Myna	*Gracupica contra*
18.	Bank Myna	*Acridotheresginginianus*
19.	Paddyfield pipit	*Anthus rufulus*
20.	Common Moorhen	*Gallinula chloropus*
21.	Indian Robin	*Saxicoloides fulicatus*
22.	House Sparrow	*Passer domesticus*
23.	Brahminy starling	*Sturnia pagodarum*
24.	Black-winged stilt	*Himantopus himantopus*
25.	Ashy Prinia	*Prinia socialis*
26.	Ring Dove	*Streptopelia capicola*
27.	Common Swallow	*Hirundo rustica*
28.	Crow Pheasant	*Centropus sinensis*
29.	Common Babbler	*Turdoides caudate*
30.	Jungle Prinia	*Prinia sylvatica*
31.	Crested Bunting	*Melophus lathami*
32.	Indian Robin	*Saxicoloides fulicatus*
33.	Black-headed Munia	*Lonchura atricapilla*
34.	Plain Prinia	*Prinia inomata*

Conclusion:-

From the present study, it may be summarized that the richness of bird species was more within 1000 m radius as compared to 200 m radius of cell phone tower which indicated that intensity of cell phone tower radiations affect the avian abundance and diversity and their effect diminishes quickly by as distance from cell phone tower increases. Avian species like Brahminy Starling, Jungle Prinia, Black-winged Stilt and Common Moorhen were not recorded within 200 m radius of cell phone tower. These species must have been affected by cell phone tower radiations as they were not recorded within 200 m radius even though the value for the Power density was within the safe limits.On the other hand, House Crow, Common Myna and Blue Rock Pigeon were found to be abundant both within 200 m and 1000 m radius of cell phone tower. This indicated that these avian species must not be affected by cell phone tower radiations. According to present study, this has been seen that there is a strong link between avian community and cell phone tower radiations. This work could be used further for similar kind of study. There is a great scope of research regarding the effect of electromagnetic radiations on birds in agro climatic zones of Punjab State. These studies may provide important information regarding the effect of electromagnetic radiation from cell phone tower on some specific avian species in agricultural habitat. A lot of research is going on in various countries so hopefully scientists and researchers may come out with the possible solution to minimize the effect of these radiations on birds.

Reference

Ali, S: The Book of Indian Birds. 13th Edn. Bombay natural History Society: Oxford University Press, Inc., Bombay (2012).

Baron, N.S: The Dark Side of Mobile Phones. Department of Language and Foreign Studies, American University, Washington, DC (2010).

Department of Telecommunications: Advisory guidelines for State Government for issue of clearance of installation of mobile towers (2013).

Gottlieb, H. E. Levkovitz, A and Monselise, E. B.: Bioassay for assessing cell stress in the vicinity of radio - frequency irradiating antennas. *Environmental Monitoring*. **13**, 1890-96 (2011).

Kalantari, S, Bigdeli, M.R. and Lahijan, i M.S.: Cellular apoptosis and blood brain barrier permeability changes in the pre-incubated chicken embryo's brain by effect of electromagnetic fields. Zahedan. *J.* R.es. *Med. Sc., i***16**, 29-34 (2014).

Krebs, C.J.: Ecology The experimental analysis of distribution and abundance. pp 513-42, Harper and Row, New York. Use of species richness, species diversity and the "Shannon-Wiener" Index. *Glob. Ecol. Biogeo., 12***,** 177-179 (1985).

Liboff, A.R. and Jenrow, K.A.: New model for the avian magnetic compass. *Bioelectromagnetics.,* **21**, 555-565 (2000).

Mouritsen, H and Ritz, T: Magnetoreception and its use in bird navigation. *Curr. Opin. Neurobiol.***15**, 406-414 (2005).

Reynolds, S. J: The effects of low dietary calcium during egg-laying on eggshell formation and skeletal calcium reserves in the zebra finch Taeniopygiaguttata. *Ibis Conservation Biol.,* **143**, 205–215 (2001).

Spellerberg, I. F. and Fedor, P.J.: A tribute to Claude Shannnon (1916-2001) and a plea for morerigorous use of species richness,diversity and the "Shannon-Wiener" Index. *Glob.Ecol. Biogeo.,* **12,**177-179 (2003).